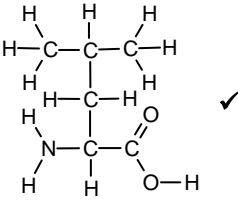
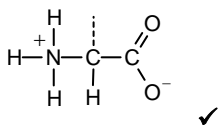
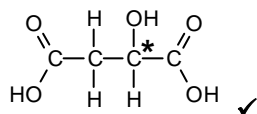


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Qu.	Expected answers:	Marks:
1	<p>(a) (i) $\text{RCH}(\text{NH}_2)\text{COOH}$ ✓</p> <p>(ii) any unambiguous structure, eg:</p>  <p>(b) (i) molecule/ion/"it" has both + and - charges</p> <p>(ii) description or diagram to show proton/H^+ transfer from COOH to NH_2 ✓</p>  <p>(c) (i) heat/warm/reflux ✓</p> <p>named strong acid/base an enzyme (which need not be named) ✓</p> <p>(ii) hydrolysis ✓</p> <p>(d) (i) (ethanolic) ammonia ✓</p> <p>(ii) any mention of chiral / optical isomers ✓</p> <p>leucine synthesised in the laboratory contains a mixture of (two optical) isomers ✓</p> <p>leucine from meat/natural source contains only one (optical) isomer ✓</p>	<p>allow groups R, CH, NH_2, COOH in any order [1]</p> <p>[1]</p> <p>[1]</p> <p>NOT just 'hydrogen' transfer</p> <p>[2]</p> <p>NOT conc HNO_3 or conc H_2SO_4 [2]</p> <p>[1]</p> <p>[1]</p> <p>[3]</p> <p>[Total: 12]</p>

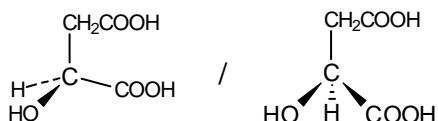
Qu.	Expected answers:	Marks:
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2 (a) (i)



[1]

(ii) structure with correct use of at least two 3-D bonds ✓ - eg

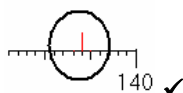


allow ecf if lactic acid is labelled in (i)

NOT if all four bond angles at 90°

[1]

(b) (i)

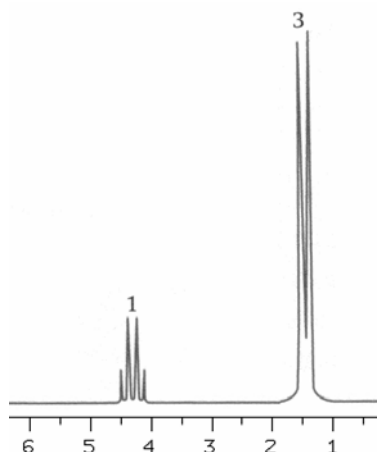


[1]

(ii) 90 ✓

[1]

(c) (i)


splitting:

doublet ✓

quartet ✓

ignore any other peaks

position:

doublet peak is at ~1.4 and

quartet peak is at ~4.3 ✓

 allow ecf from **one** incorrect splitting pattern

areas:

1 and 3 on the correct peaks

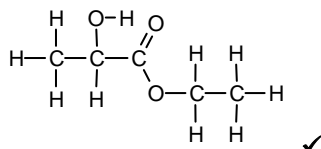
(or either way round as ecf if any errors above) ✓

(ii) 4 ✓

 OH/labile protons now visible **AW** ✓

[2]

(d) (i)



[1]

(ii) any sensible change in flavour linked to the presence of the ester or loss of the acid ✓ - eg

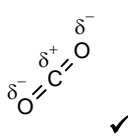
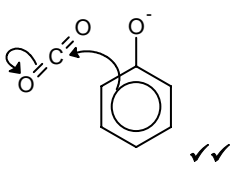
"more fruity due to the ester"

"less sour as acids get used up"

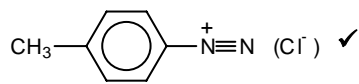
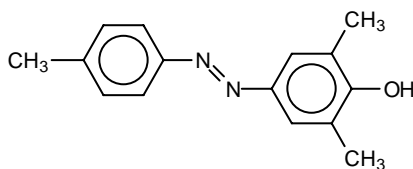
[1]

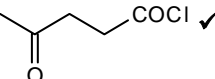
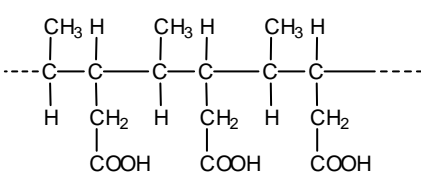
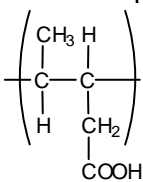
[Total: 12]

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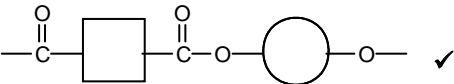
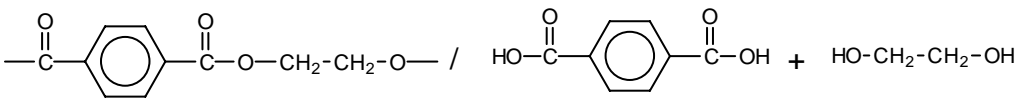
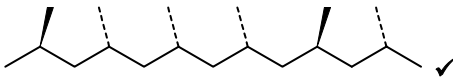
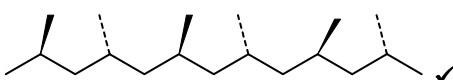
Qu.	Expected answers:	Marks:
3 (a) (i)	NaOH / Na ✓	[1]
(ii)	$\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \longrightarrow \text{C}_6\text{H}_5\text{O}^-\text{Na}^+ + \text{H}_2\text{O} /$ $\text{C}_6\text{H}_5\text{OH} + \text{Na} \longrightarrow \text{C}_6\text{H}_5\text{O}^-\text{Na}^+ + \frac{1}{2}\text{H}_2 \quad \checkmark$	[1]
(b) (i)		<p>allow a dipole on just one C=O bond</p> <p>[1]</p>
(ii)		[2]
(iii)	<p>lone/electron <u>pair</u> from oxygen is delocalised into the ring /interacts with π-electrons ✓</p> <p>increases π-electron density / negative charge (around the ring) ✓</p> <p>attracts electrophiles more ✓</p>	[3]
(c)	<p>M_r salicylic acid = 138 ✓</p> <p>moles (in 1:1 reaction) = $3500 \times 10^6 / 138 = 2.536 \times 10^7$ ✓</p> <p>mass of phenol needed = $2.536 \times 10^7 \times 94 = 2384$ tonnes ✓</p> <p>allowing for 45% yield = $2384 \times \frac{100}{45} = \mathbf{5298/5300}$ (tonnes) ✓</p>	<p>allow 5297.5 –5300</p> <p>allow ecf throughout [4]</p>
		[Total: 12]

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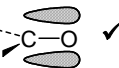
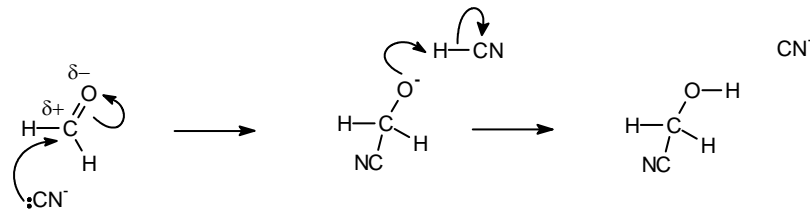
Qu.	Expected answers:	Marks:	
4 (a) (i)	nitrous acid / HNO_2	[1]	
(ii)		[1]	
(iii)	diazonium (ion /salt) ✓	[1]	
(iv)	to prevent decomposition / it reacting (diazonium ion) is unstable AW	[1]	
(v)	structure showing the amine coupled to the phenol or its salt – eg		
			
	-N=N- ✓ rest of structure (joined by two nitrogens) ✓	[2]	
(b)	<p>methylation stage (can come anywhere)</p> <p>CH_3Cl / CH_3Br ✓</p> <p>AlCl_3 / FeBr_3 etc ✓</p> <p>equation - eg $\text{C}_6\text{H}_6 + \text{CH}_3\text{Cl} \longrightarrow \text{C}_6\text{H}_5\text{CH}_3 + \text{HCl}$ ✓</p> <p>intermediate name or unambiguous structure ✓</p> <p style="text-align: right;">4 marks</p> <p>nitration stage</p> <p>(conc) H_2SO_4 ✓</p> <p>(conc) HNO_3 ✓</p> <p>equation – eg: $\text{C}_6\text{H}_5\text{CH}_3 + \text{HNO}_3 \longrightarrow \text{C}_6\text{H}_4(\text{CH}_3)\text{NO}_2 + \text{H}_2\text{O}$ ✓</p> <p>intermediate – name or unambiguous structure ✓</p> <p style="text-align: right;">4 marks</p> <p>reduction stage</p> <p>tin/iron ✓</p> <p>HCl ✓</p> <p>equation – eg: $\text{C}_6\text{H}_4(\text{CH}_3)\text{NO}_2 + 6[\text{H}] \longrightarrow \text{C}_6\text{H}_4(\text{CH}_3)\text{NH}_2 + 2\text{H}_2\text{O}$</p> <p style="text-align: center;">or with H^+ also on left to give $\text{C}_6\text{H}_4(\text{CH}_3)\text{NH}_3^+$ ✓</p> <p style="text-align: right;">3 marks</p> <p>quality of written communication mark for a well organised answer with the three stages clearly distinguished and sequenced ✓</p> <p style="text-align: right;">1 mark</p>	<p>intermediates and equations will vary if methylation is done after nitration or reduction</p> <p>allow other suitable reducing agents:</p>	
		[12]	
		[Total: 18]	

Qu.	Expected answers:	Marks:
5 (a) (i)	NaBH ₄ ✓	[1]
(ii)	4-hydroxypentanoic acid ✓	[1]
(iii)	any correct structure - eg  ✓	[1]
(b) (i)	section of the polymer ✓ – eg 	[1]
(ii)	a correct repeat shown ✓ –eg 	allow ecf from (i) only if the repeat is every 2 carbons along the chain and has a COOH [1]
(c) (i)	C ₇ H ₁₂ O ₃ ✓	[1]
(ii)	C ₇ H ₁₂ O ₃ + 8½O ₂ → 7CO ₂ + 6H ₂ O or ecf from (i) formulae ✓ balancing ✓	[2]
(iii)	idea of providing oxygen / reducing incomplete combustion AW ✓	[1]
(d) (i)	heat/warm/reflux ✓ NaOH / KOH (aq) ✓	[2]
(ii)	G is an ester / sensible argument based on polarity ✓	[1]
		[Total: 12]

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Qu.	Expected answers:	Marks:
6 (a) (i)	(question wording unclear - ignore response and credit the mark)	[1]
(ii)	attempt at a polymer containing an ester link ✓ correct repeat of any polyester of the form:  ✓ repeat unit or monomers are correct for Terylene ✓ -ie  (allow correct names of the monomers)	[3]
(b)	polymer P contains C=O ✓ is Terylene ✓ polymer R has no O-H / peak at 3230-3550 / has no C-O / peak at 1000-1300 ✓ is a hydrocarbon ✓ any 3 out of 4 marks	ignore the C-O bond range for P [3]
(c) (i)	poly(phenylethene) / polystyrene ✓	[1]
(ii)	atactic = random (or shown by diagram) ✓ syndiotactic = alternating (or shown by diagram) ✓ correct diagram of poly(propene) showing side chains randomly arranged along the chain - eg  ✓ correct diagram of poly(propene) showing side chains alternating along the chain - eg  ✓ correct use of 3-D bonds (on at least one diagram) ✓	allow formulae also showing H atoms (but then needs two 3-D bonds on each carbon for the last mark) [5]
		[Total: 13]

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Qu.	Expected answers:	Marks:
7 (a)	<p><i>π-bonding in the carbonyl group</i></p> <p>overlap of p-orbitals (or shown in diagram) ✓</p> <p>description of π-bond above and below C-O /shown in diagram - eg  ✓</p> <p style="text-align: right;">2 marks</p> <p><i>reactivity with electrophiles and nucleophiles</i></p> <p>C is δ^+ / description of polarisation of C=O ✓</p> <p>electrophiles will be repelled / nucleophiles will be attracted by the $C^{\delta+}$ AW or idea that π-bond electrons are unavailable (due to the polarisation) ✓</p> <p style="text-align: right;">2 marks [4]</p> <p><i>mechanism</i></p> <p>CN⁻ or other suitable nucleophile chosen (allow H⁻, OH⁻, NH₃, H₂O etc) ✓ – eg</p> <div style="text-align: center;">  </div> <p>curly arrow from correct atom of nucleophile to carbonyl C ✓ polarisation of $C^{\delta+}=O^{\delta-}$ and curly arrow from π-bond to O ✓</p> <p>structure of the correct intermediate (from methanal) ✓ curly arrow from O⁻ to H⁺ (or the H of H-CN or other suitable donor - eg H₂O) ✓</p> <p>correct organic product (or ecf if a carbonyl other than methanal) ✓</p> <p style="text-align: right;">6 marks [6]</p> <p><i>quality of written communication</i> mark for at least two legible sentences with correct spg that attempt to answer the question ✓</p> <p style="text-align: right;">[1]</p> <p style="text-align: right;">[Total: 11]</p>	